



# Connector and Wiring Guidelines

## For Typical Twisted Pair LONWORKS™ Networks

March 1992

LONWORKS™ Engineering Bulletin

### Introduction

This paper identifies the different types of junction boxes and interconnections that may be used in twisted pair LONWORKS networks in building and industrial control applications. The recommendations presented herein are intended to assist electrical system designers, interconnection device manufacturers, and cable manufacturers, and are provided for informational purposes only.

Four types of junction box topologies are discussed below:

- Pass-Thru
- Stub Connectorized
- Local Loop Connectorized
- Local Loop Terminal

The Pass-Thru Junction Box is intended to be a splice point only and does not include interconnections for a local node. The Stub Connectorized Junction Box provides both a connectorized stub for a local node and a convenient splice point for cables passing to the previous and next junction boxes. The Local Loop Connectorized Junction Box provides a connectorized local loop for a node and a splice point for cables passing to the previous and next junction boxes. Likewise, the Local Loop Terminal Junction Box provides terminals for a local loop and a splice point for cables passing to the previous and next junction boxes. These two junction boxes are intended to be used when the distance between the junction box and the local node exceeds the allowed stub length, or when a loop-style architecture is desirable.

References are provided for commercially available junction boxes that appear to perform the required functions. It should be noted, however, that these junction boxes have not been tested by Echelon for their suitability or performance, and Echelon makes no claims whatever about the usefulness of these devices.

## Definition of Terms

Color Code	The color of the LONWORKS network cable conductors. In two wire systems the colors will be white/blue (W/B) and blue (B). In four wire systems the colors will be white/blue (W/B), blue (B), white/orange (W/O)), and orange (O). A shield drain wire (S) may be provided in either two or four wire networks, and will be clearly designated by color coding or other markings as being a shield or drain wire.
Connector	A polarized, locking, removable connector assembly having two halves, female and male. The female half will be integral to the junction box. The male half will be removable and will include a restraining device that firmly locks the two connector halves in place when coupled. The locking mechanism will be unlocked by the application of slight finger pressure at one or more tabs on the male connector.
DB-9/DB-25	A 9 or 25 conductor, polarized, removable, gold-flashed, D-type connector.
Flying Lead	A length of insulated, stranded wire, minimum 22AWG wire.
4-Wire Central Power	Locally powered nodes that are powered by a central power supply via an additional wire pair that is provided for power distribution.
IN	Wiring that originates at the previous node.
Insulation Displacement Terminal	A connector arrangement in which wiring is affixed to insulation displacement terminals. Multiple wires can be attached to a single connector buss either by permitting two conductors to be inserted in the same displacement terminal, or by providing two or more displacement terminals on a common buss.

Pass-Thru	A junction box at which wires are spliced, and to which no nodes are connected.
2-Wire Link Power	2-wire link power permits the transmission of both node power and network data on a common pair of wires. Link powered nodes may or may not require local power depending on the system topology and local power consumption levels.
Local Loop	A loop of bus cable that exits from a junction box, interconnects with a node, and returns to the junction box.
Local Power	A power source that provides operating power to a locally powered node.
OUT	Wiring that originates at the current node.
RJ-45	An eight conductor, polarized, removable, gold-flashed connector.
Screw Terminal	A connector arrangement in which wiring is affixed to screw terminals. Washers are provided to separate multiple conductors attached to a single screw.
Stub	A T-tap from a bus cable that originates at a junction box and terminates at a node.

## Pass-Thru Junction Box

A pass-thru junction box provides a convenient point at which to splice two cables. No nodes or connectors are provided at a pass-thru junction box. There are three primary methods of implementing a splice at a pass-thru junction box:

1. **Screw Terminals 8/10 Wire:** IN and OUT wires are stripped and wrapped around screw terminals, which are tightened to retain the wires and make a secure electrical contact. Each screw is supplied with two or more washers. The washers separate conductors where multiple wires are landed at one screw, thereby preventing wires from being ejected as the screw is tightened. Each screw terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. IN terminals 1-5 are connected directly by busses, circuit card traces, or wire jumpers, to OUT terminals 1-5, respectively. These connections provide the "pass-thru" function by routing the incoming signals to the outgoing terminals.
2. **Insulation Displacement Terminals 8/10 Wire:** IN and OUT wires are punched down on barrel or telco insulation displacement terminals. Each barrel or telco terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. IN terminals 1-5 are connected directly by busses, circuit card traces, or wire jumpers, to OUT terminals 1-5, respectively. These connections provide the "pass-thru" function by routing the incoming signals to the outgoing terminals.
3. **Crimp Connectors:** IN and OUT wires are spliced together using crimp connectors. The connectors are then fitted inside the junction box, which itself contains no terminals. The connectors support two 24AWG or two 22AWG or one each 24AWG and 22AWG wires, and are compatible with both stranded and solid wire.

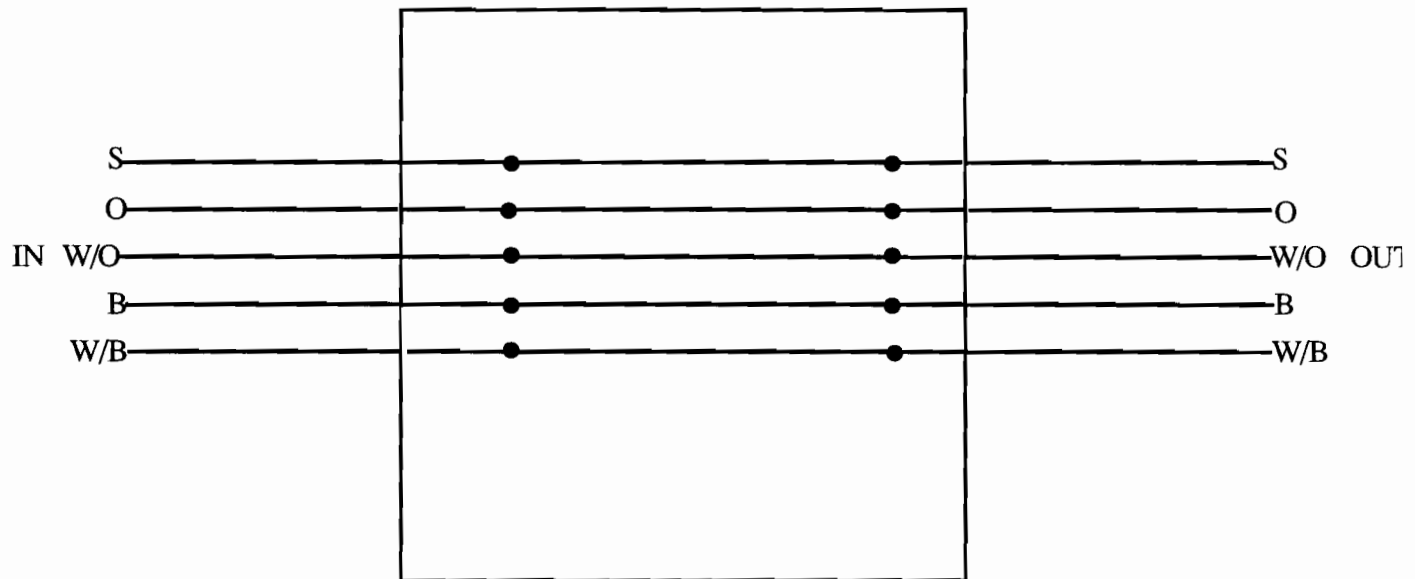
The following section applies to all three versions of a pass-thru junction box.

The junction box includes either separate cover and base parts, or a hinged cover that can be opened sufficiently wide to provide access to all terminals and cable entry holes. Cable entry holes will be sufficiently large to support 2-pair shielded UL/Anixter Level IV jacketed plenum cable. The base of the junction box includes either strain relief structures or grommets which provide strain relief by compression when inserted in holes in the base. Sufficient room is provided to allow three inches (3") of IN and OUT wire service loop to be stored inside of the junction box. A minimum of 3/8" clearance will be provided around the inner perimeter of the junction box for wire routing.

The junction box is provided both with screw mounting holes and double sided adhesive tape. The junction box cover either snap-locks or is secured with screws or straps.

The lower left corner of the cover includes a space in which up to 20 12-point font letters can be written by a customer to identify the junction box number and function.

### Pass-Thru Terminal Junction Box



### Terminal Legend

<u>Terminal</u>	<u>Wire Color</u>	<u>Function</u>
1	White/Blue	Data comm. or + for 2-wire link power
2	Blue	Data comm. or - for 2-wire link power
3	White/Orange	Power + if locally powered
4	Orange	Power GND if locally powered
5	S - Shield	Cable shield if used

### Junction Box Manufacturers

<u>Type</u>	<u>Quantity</u>	<u>Manufacturer</u>	<u>Model Number</u>
Screw Terminal	1	GC Thorsen	30-9805
Screw Terminal	1	Suttle	SE-44A
Insulation Displacement	1	3M	4110
Crimp Connectors	5	3M	ULG

## Stub Connectorized Junction Box

A stub connectorized junction box provides a convenient point at which to splice two cables and provide a stub for servicing a local node. A removable, polarized, locking connector is provided for connection to the local node. There are four primary methods of implementing a stub connectorized junction box:

1. **Screw Terminal 10 Wire Pin Connector:** IN and OUT wires are stripped and wrapped around screw terminals, which are tightened to retain the wires and make a secure electrical contact. Each screw is supplied with two or more washers. The washers separate conductors where multiple wires are landed at one screw, thereby preventing wires from being ejected as the screw is tightened. Each screw terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. A removable, polarized, locking 10 pin connector is provided for connection to the local node.
2. **Screw Terminal 8 Wire RJ-45 or DB-9/25:** IN and OUT wires are stripped and wrapped around screw terminals, which are tightened to retain the wires and make a secure electrical contact. Each screw is supplied with two or more washers. The washers separate conductors where multiple wires are landed at one screw, thereby preventing wires from being ejected as the screw is tightened. Each screw terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire.

The screw terminals are connected to a female connector attached to either the base or cover of the junction box. The local node is connected to the junction box via a male connector. The RJ-45 is an eight terminal connector, and therefore will not support IN and OUT four wire cables with shields. The DB-9 is a nine terminal connector, and therefore will not support both IN and OUT four wire cables with shields. IN terminals 1-4 are connected directly by busses, circuit card traces, or wire jumpers, to OUT terminals 1-4, respectively. These connections provide the "pass-thru" function by routing the incoming signals to the outgoing terminals.

3. **Insulation Displacement 10 Wire Pin Connector:** IN and OUT wires are punched down on barrel or telco insulation displacement terminals. Each Barrel or telco terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. Both stranded and solid conductor wires are supported. A removable, polarized, locking 10 pin connector is provided for connection to the local node.

4. Insulation Displacement 8 Wire RJ-45 or DB-9/25: IN and OUT wires are punched down on barrel or telco insulation displacement terminals. Each Barrel or telco terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. The screw terminals are connected to a female connector attached to either the base or cover of the junction box. The local node is connected to the junction box via a male connector. The RJ-45 is an eight terminal connector, and therefore will not support IN and OUT four wire cables with shields. The DB-9 is a nine terminal connector, and therefore will not support both IN and OUT four wire cables with shields.

The following section applies to all four versions of a stub connectorized junction box.

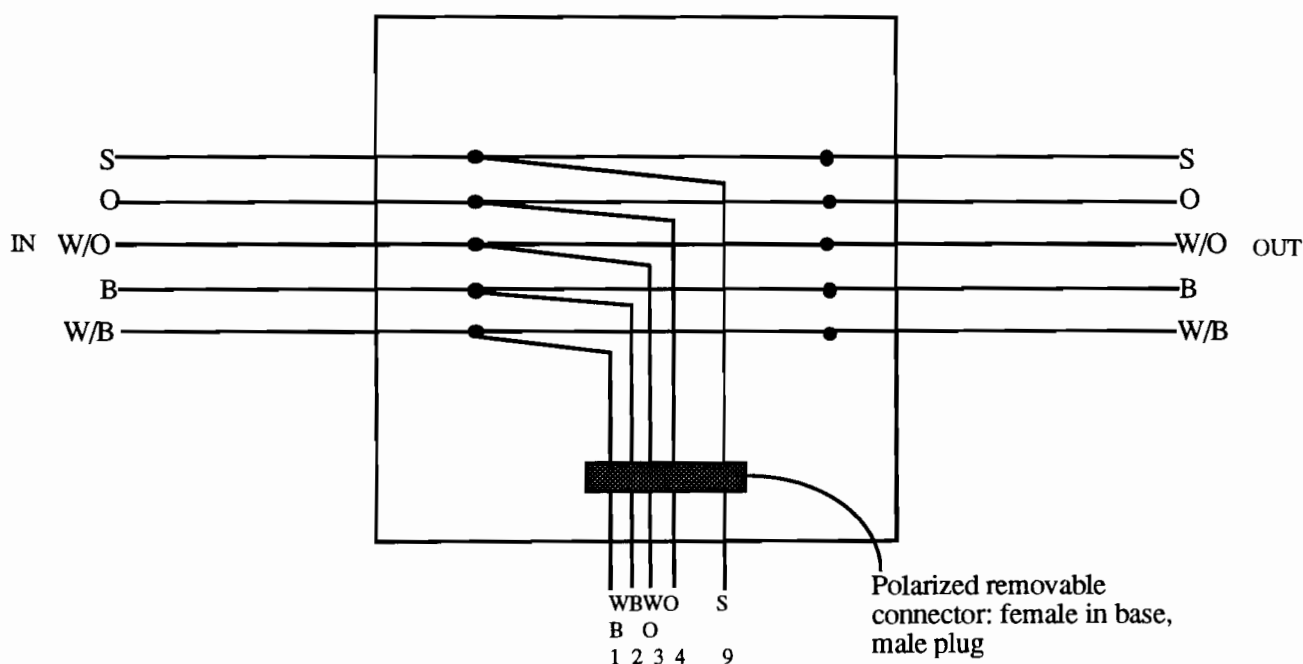
IN terminals 1-5 are connected directly by busses, circuit card traces, or wire jumpers, to OUT terminals 1-5, respectively. These connections provide the "pass-thru" function by routing the incoming signals to the outgoing terminals.

The junction box includes either separate cover and base parts, or a hinged cover that can be opened sufficiently wide to provide access to all terminals and cable entry holes. Cable entry holes will be sufficiently large to support 2-pair shielded UL/Anixter Level IV jacketed plenum cable. The base of the junction box includes either strain relief structures or grommets which provide strain relief by compression when inserted in holes in the base. Sufficient room is provided to allow three inches (3") of IN and OUT wire service loop to be stored inside of the junction box. A minimum of 3/8" clearance will be provided around the inner perimeter of the junction box for wire routing.

The junction box is provided both with screw mounting holes and double sided adhesive tape. The junction box cover either snap-locks or is secured with screws or straps.

The lower left corner of the cover includes a space in which up to 20 12-point font letters can be written by a customer to identify the junction box number and function.

### Stub Connectorized Junction Box



#### Terminal Legend

<u>Terminal</u>	<u>Wire Color</u>	<u>Function</u>
1	White/Blue	Data comm. or + for 2-wire link power
2	Blue	Data comm. or - for 2-wire link power
3	White/Orange	Power + if locally powered
4	Orange	Power GND if locally powered
5	S - Shield	Cable shield if used

#### Removable Connector Legend

<u>Terminal</u>	<u>Wire Color</u>	<u>Function</u>
1	White/Blue	IN Data comm. or + for 2-wire link power
2	Blue	IN Data comm. or - for 2-wire link power
3	White/Orange	IN Power + if locally powered
4	Orange	IN Power GND if locally powered
5-8	Not used	
9	S - Shield	IN Cable shield
10	Not used	

#### Junction Box Manufacturers

<u>Type</u>	<u>Quantity</u>	<u>Manufacturer</u>	<u>Model Number</u>
Screw Terminal RJ-45	1	GC Thorsen	30-9660/9706
Insulation Displacement RJ-45	1	Suttle	SE-625A3-8SB
Insulation Displacement RJ-45	1	AMP	554269-2
Screw Terminal DB-9/25	1	AESP	W9/W25



## Local Loop Connectorized Junction Box

A local loop connectorized junction box provides a convenient point at which to terminate two cables and provide a wiring loop for servicing a local node. A removable, polarized, locking connector is provided for connection to the local node. There are four primary methods of implementing a local loop connectorized junction box:

1. **Screw Terminal 10 Wire Pin Connector:** IN and OUT wires are stripped and wrapped around screw terminals, which are tightened to retain the wires and make a secure electrical contact. Each screw is supplied with two or more washers. The washers separate conductors where multiple wires are landed at one screw, thereby preventing wires from being ejected as the screw is tightened. Each screw terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. A removable, polarized, locking 10 pin connector is provided for connection to the local node.
2. **Screw Terminal 8 Wire RJ-45 or DB-9/25:** IN and OUT wires are stripped and wrapped around screw terminals, which are tightened to retain the wires and make a secure electrical contact. Each screw is supplied with two or more washers. The washers separate conductors where multiple wires are landed at one screw, thereby preventing wires from being ejected as the screw is tightened. Each screw terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. The screw terminals are connected to a female connector attached to either the base or cover of the junction box. The local node is connected to the junction box via a male connector. The RJ-45 is an eight terminal connector, and therefore will not support IN and OUT four wire cables with shields. The DB-9 is a nine terminal connector, and therefore will not support both IN and OUT four wire cables with shields.
3. **Insulation Displacement 10 Wire Pin Connector:** IN and OUT wires are punched down on barrel or telco insulation displacement terminals. Each Barrel or telco terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. Both stranded and solid conductor wires are supported. A removable, polarized, locking 10 pin connector is provided for connection to the local node.
4. **Insulation Displacement 8 Wire RJ-45 or DB-9/25:** IN and OUT wires are punched down on barrel or telco insulation displacement terminals. Each Barrel or telco terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. The screw terminals are

connected to a female connector attached to either the base or cover of the junction box. The local node is connected to the junction box via a male connector. The RJ-45 is an eight terminal connector, and therefore will not support IN and OUT four wire cables with shields. The DB-9 is a nine terminal connector, and therefore will not support both IN and OUT four wire cables with shields.

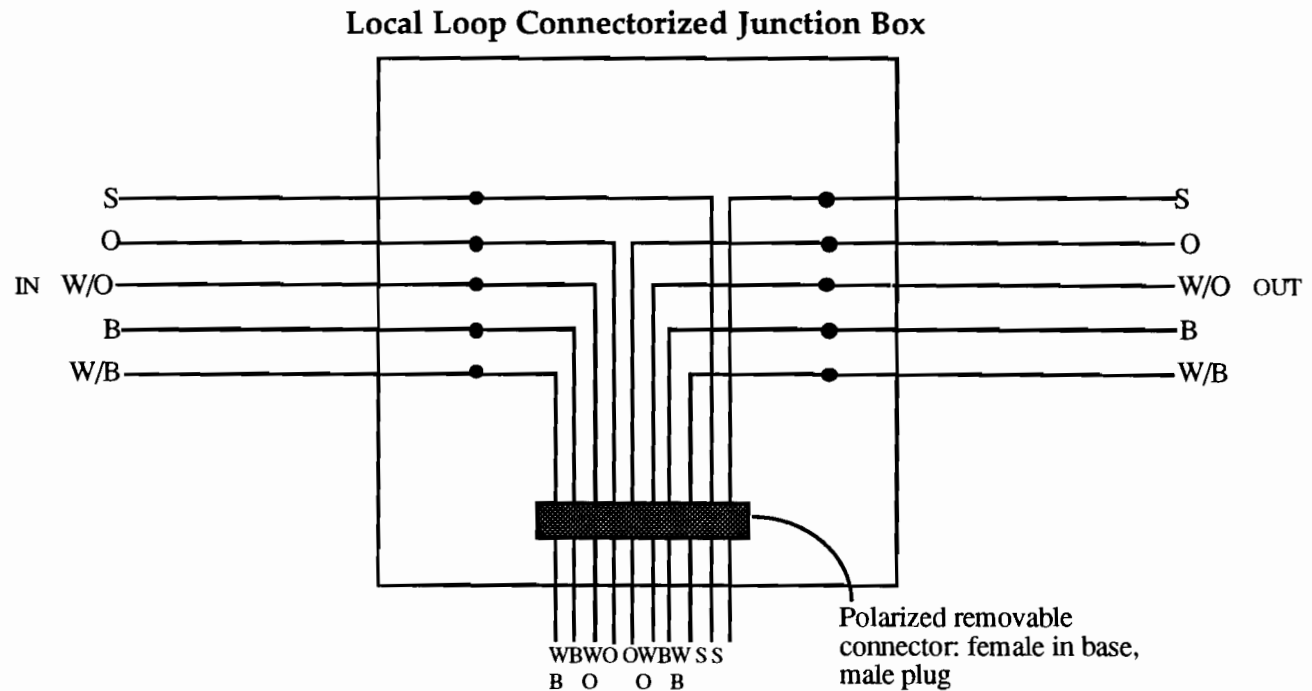
The following section applies to all four versions of a local loop connectorized junction box.

IN terminals and OUT terminals are isolated from each other: this junction box does not perform a "pass-thru" function.

The junction box includes either separate cover and base parts, or a hinged cover that can be opened sufficiently wide to provide access to all terminals and cable entry holes. Cable entry holes will be sufficiently large to support 2-pair shielded UL/Anixter Level IV jacketed plenum cable. The base of the junction box includes either strain relief structures or grommets which provide strain relief by compression when inserted in holes in the base. Sufficient room is provided to allow three inches (3") of IN and OUT wire service loop to be stored inside of the junction box. A minimum of 3/8" clearance will be provided around the inner perimeter of the junction box for wire routing.

The junction box is provided both with screw mounting holes and double sided adhesive tape. The junction box cover either snap-locks or is secured with screws or straps.

The lower left corner of the cover includes a space in which up to 20 12-point font letters can be written by a customer to identify the junction box number and function.



#### Terminal Legend

<u>Terminal</u>	<u>Wire Color</u>	<u>Function</u>
1	White/Blue	Data comm. or + for 2-wire link power
2	Blue	Data comm. or - for 2-wire link power
3	White/Orange	Power + if locally powered
4	Orange	Power GND if locally powered
5	S - Shield	Cable shield if used

#### Removable Connector Legend

<u>Terminal</u>	<u>Wire Color</u>	<u>Function</u>
1	White/Blue	IN Data comm. or + for 2-wire link power
2	Blue	IN Data comm. or - for 2-wire link power
3	White/Orange	IN Power + if locally powered
4	Orange	IN Power GND if locally powered
5	Orange	OUT Power GND if locally powered
6	White/Orange	OUT Power + if locally powered
7	Blue	OUT Data comm. or - for 2-wire link power
8	White/Blue	OUT Data comm. or + for 2-wire link power
9	S - Shield	IN Cable shield
10	S - Shield	OUT Cable shield

#### Junction Box Manufacturers

<u>Type</u>	<u>Quantity</u>	<u>Manufacturer</u>	<u>Model Number</u>
Screw Terminal RJ-45	1	Suttle	SE-468DV88
Insulation Displacement RJ-45	1	AMP	554269-2
Screw Terminal DB-9/25	1	AESP	W9/W25

## Local Loop Terminal Junction Box

A local loop terminal junction box provides a convenient point at which to terminate two cables and provide a wiring loop for servicing a local node. The local node is wired directly to the junction box, and no removable connectors are provided. There are two primary methods of implementing a local loop terminal junction box:

1. **Screw Terminal 8/10 Wire:** IN and OUT wires are stripped and wrapped around screw terminals, which are tightened to retain the wires and make a secure electrical contact. Each screw is supplied with two or more washers. The washers separate conductors where multiple wires are landed at one screw, thereby preventing wires from being ejected as the screw is tightened. Each screw terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. The local node is wired directly to the In and OUT terminals.
2. **Insulation Displacement 8/10 Wire:** IN and OUT wires are punched down on barrel or telco insulation displacement terminals. Each Barrel or telco terminal supports two 24AWG or two 22AWG or one each 24AWG and 22AWG wires landed at the same terminal. The terminals are compatible with both stranded and solid wire. The local node is wired directly to the In and OUT terminals.

The following section applies to both versions of a local loop connectorized junction box.

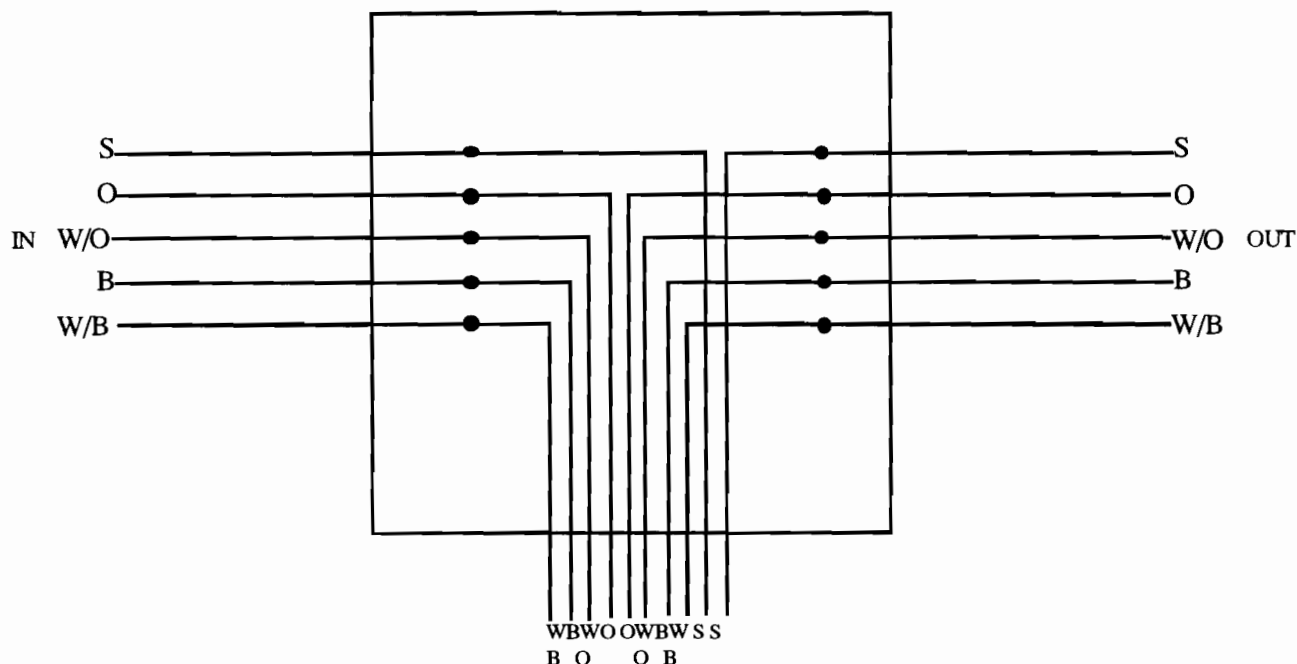
IN terminals and OUT terminals are isolated from each other: this junction box does not perform a "pass-thru" function.

The junction box includes either separate cover and base parts, or a hinged cover that can be opened sufficiently wide to provide access to all terminals and cable entry holes. Cable entry holes will be sufficiently large to support 2-pair shielded UL/Anixter Level IV jacketed plenum cable. The base of the junction box includes either strain relief structures or grommets which provide strain relief by compression when inserted in holes in the base. Sufficient room is provided to allow three inches (3") of IN and OUT wire service loop to be stored inside of the junction box. A minimum of 3/8" clearance will be provided around the inner perimeter of the junction box for wire routing.

The junction box is provided both with screw mounting holes and double sided adhesive tape. The junction box cover either snap-locks or is secured with screws or straps.

The lower left corner of the cover includes a space in which up to 20 12-point font letters can be written by a customer to identify the junction box number and function.

### Local Loop Terminal Junction Box



### Terminal Legend

<u>Terminal</u>	<u>Wire Color</u>	<u>Function</u>
1	White/Blue	Data comm. or + for 2-wire link power
2	Blue	Data comm. or - for 2-wire link power
3	White/Orange	Power + if locally powered
4	Orange	Power GND if locally powered
5	S - Shield	Cable shield if used

### Removable Connector Legend

<u>Terminal</u>	<u>Wire Color</u>	<u>Function</u>
1	White/Blue	IN Data comm. or + for 2-wire link power
2	Blue	IN Data comm. or - for 2-wire link power
3	White/Orange	IN Power + if locally powered
4	Orange	IN Power GND if locally powered
5	Orange	OUT Power GND if locally powered
6	White/Orange	OUT Power + if locally powered
7	Blue	OUT Data comm. or - for 2-wire link power
8	White/Blue	OUT Data comm. or + for 2-wire link power
9	S - Shield	IN Cable shield
10	S - Shield	OUT Cable shield

## Junction Box Manufacturers

<u>Type</u>	<u>Quantity</u>	<u>Manufacturer</u>	<u>Model Number</u>
Screw Terminal	1	Suttle	SE-44A
Insulation Displacement	1	3M	4012-E/ULG

## Summary

This document has described several methods of interconnecting twisted pair LONWORKS networks. There are many alternate wiring and connector architectures that might better suit a particular application or industry, and this document is therefore not intended to be an exhaustive guide. As new designs are reviewed by Echelon, this guide will be expanded accordingly.

## Product Manufacturers

### *Junction Box Suppliers*

AESP  
1810 N.E. 144th Street  
N. Miami, Florida 33181  
Phone: 305-944-7710  
FAX: 305-652-8489

AMP, Inc.  
P.O. Box 3608  
Harrisburg, Pennsylvania 17105  
Phone: 717-564-0100

GC Thorsen  
1801 Morgan Street  
Rockford, Illinois 61102  
Phone: 815-968-9661  
FAX: 815-968-9731

Suttle Apparatus  
P.O. Box 548  
Hector, Minnesota 55342  
Phone: 612-848-6711  
FAX: 612-848-6218

3M Telecom Systems Group  
P.O. Box 2963  
Austin, Texas 78769  
Phone: 512-984-6766  
FAX: 512-984-3408

*Level IV Cable Suppliers*

Belden  
P.O. Box 1980  
Richmond, Indiana 47375  
Phone: 317-983-5200

Berk-Tec  
132 White Oak Road  
New Holland, Pennsylvania 17557  
Phone: 717-354-6200  
FAX: 717-354-7944

Brand Rex  
1600 West Main Street  
Willimantic, Connecticut 06226  
Phone: 203-456-8000

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Rev. A

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